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Richard W. Sternberg Nels J. Sultan			
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The award was made to Professor Richard W. Sternberg at the University of Washington, School of Oceanography. Dr Nels J. Sultan, a coastal engineer, was selected by Dr Sternberg to fill the position of Research Associate - Postdoctoral funded by the award. The focus of Dr Sultan's research efforts has been to apply Particle Image Velocimetry to field measurements in and near the surf zone. A research plan was developed and executed which involved acquiring a laboratory PIV system from TSI, Inc., adapting it for measurements in the field and taking it to Duck, North Carolina, for measurements in the ocean at the US Army Corps of Engineers Field Research Facility. The Sensor Insertion System was used to deploy the instruments in the ocean. Successful experiments were performed in July 1996. Data was acquired and analyzed. Results have been reported at seminars and via publications and other activities.			
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Office of Naval Research - Ocean Science Educator Award
Summary of Activities

The Ocean Science Educator Award is funded by the Office of Naval Research. It is a three year appointment for investigating nearshore hydrodynamics and sediment transport mechanics. An important condition was that the person funded by the award must not have an oceanography degree, thereby bringing in people from related sciences with perhaps different perspectives from oceanographers. The award was made to Professor Richard W. Sternberg at the University of Washington, School of Oceanography. Dr. Nels J. Sultan, a coastal engineer, was selected by Dr. Sternberg to fill the position of Research Associate - Post-doctoral funded by the award.

The focus of Dr. Sultan's research efforts has been to apply Particle Image Velocimetry to field measurements in and near the surf zone. A research plan was developed and executed which involved acquiring a laboratory PIV system from TSI, Inc., adapting it for measurements in the field and taking it Duck, North Carolina for measurements in the ocean at the US Army Corps of Engineers Field Research Facility. The Sensor Insertion System was used to deploy the instruments in the ocean. Successful experiments were performed in July 1996. Data was acquired and analyzed. Results have been reported at the seminars and activities listed below.

Unique images and data were acquired, including velocity measurements in and near the wave bottom boundary layer. This is the first time PIV, which is a laboratory tool, has been applied outside the lab to make field measurements. Compared with existing field instruments, PIV allows velocity measurements at far greater spatial resolutions.

Listed below are the seminars, publications and activities performed in connection with the Ocean Science Educator Award.

Papers

Sultan, N.J., Boughner, J.A. and McPhee, E.E. (1998) "Fine Scale Field Measurements of Near Bottom Kinematics." *Journal of Geophysical Research (Oceans)* (in progress).

Sultan, N.J. (1998) "Fine Scale Particle Image Velocimetry Measurements in the Ocean." *Experiments in Fluids* (in progress).

Refereed Abstracts

Sultan, N.J. (1997) "Fine Scale Field Measurements of Near Bottom Kinematics." *American Geophysical Union Fall Meeting (Nearshore Processes - Ocean Sciences)*.

Kubota, C.A, Ladd, C., Strickland, R., Sultan, N.J., McManus, D.A. (1997) "A Science Teaching Methods Course: Using a Wetlands Immersion to Implement the National Science Education Standards." *GSA Annual Meeting*.

Sultan, N.J. and Boughner, J.A. (1996). "Nearshore Field Measurements Using Particle Image Velocimetry", *American Geophysical Union Fall Meeting (Nearshore Processes - Ocean Sciences)*.

Sultan, N.J. and Ting, F.C.K. (1995). "Turbulence Measurements in a Laboratory Surf Zone." *American Geophysical Union Fall Meeting (Nearshore Processes - Ocean Sciences)*.

Seminar Presentations

1997 - "Near Bottom Kinematics - Field Measurements Using PIV" Annual Conference of Northwest Coastal Engineering Schools (University of British Columbia, University of Washington and Oregon State University). Held at the University of British Columbia.

1996 - "Particle Image Velocimetry in the Ocean" Annual Conference of Northwest Coastal Engineering Schools (University of British Columbia, University of Washington and Oregon State University). Held at Oregon State University.

Professional Activities

1997 September to December, Consulting work for Hartman Associates, Inc. Worked approximately five hours/week developing an oceanographic instrumentation plan for measurement of circulation in a harbor in the Caribbean.

1996 January to March. Worked with a team of outside scientists in a wetlands immersion experiment teaching science to students in a teacher certification course at the University of Washington - Bothell, School of Education.

Nearshore Field Measurements Using Particle Image Velocimetry

N.J. Sultan (School of Oceanography, University of Washington, Seattle, WA 98195-7940; (206) 543-5099; e-mail: sultan@ocean.washington.edu)

Measurements are made in the field using a digital Particle Image Velocimetry (PIV) system. The PIV system uses a 5 Watt laser light sheet to illuminate a plane in the fluid. A video camera records to videotape microscopic particles illuminated by the laser. A desktop computer then calculates the velocity field based on the motion of the illuminated particles. The system is a laboratory tool which has been adapted for use in the field.

Measurements were made at the Army Corps of Engineer's Field Research Facility at Duck, North Carolina in June/July 1996. The Sensor Insertion System (SIS) was used to place the video camera, laser light sheet, and other instruments in about 1.5 m water depth above a sandy beach. The SIS is a modified gantry crane which allows precise placement of instruments in and near the surf zone.

The PIV measurements provided velocity data at far higher spatial resolutions than existing field instruments, such as electro-magnetic current meters. A typical interrogation area of 10 cm by 6 cm is analyzed to provide a 10 by 10 vector field at a sampling rate of 30 Hz. Measurements included the bottom boundary layer and showed many important features such as eddies being shed from ripples. In addition to the velocity data, the PIV system provided valuable qualitative flow visualization information. Sediment suspension events are clearly visible and are compared with measurements from optical backscatter sensors.

Velocities in the bottom boundary layer are compared with results from theoretical and experimental studies. In the middle of the water column and near bottom, turbulence parameters are calculated and compared with data from existing studies.

1. 1996 Fall Meeting
2. Membership # 30010516
3. (a) Nels Sultan
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4. O
5. (a) OS10 Nearshore and Inner Shelf Processes
(b) 4546 Nearshore processes
4560 Surface waves and tides (1255)
4568 Turbulence, diffusion and mixing processes
6. oral presentation preferred in order to show videotape.
7. ---
8. 0% previously published
9. \$50 check enclosed
10. C
11. ---
12. No
13. No

Turbulence Measurements in a Laboratory Surf Zone

N.J. Sultan (School of Oceanography, University of Washington, Seattle, WA 98195-7940; (206) 543-5099; e-mail: sultan@ocean.washington.edu)

F.C.K. Ting (Department of Civil Engineering, Texas A&M University, College Station, Texas 77843-3135; (419) 862-2853; e-mail: fct0675@venus.tamu.edu)
(Sponsor: R.W. Sternberg)

Experiments are performed in a two-dimensional wave tank with a sloping beach at one end. Irregular waves are generated and the water particle velocity measured under the breaking waves with a laser Doppler velocimeter. The effect of turbulence on the flow is studied using the Reynold's averaged momentum and energy equations. By taking measurements on a grid and by ensemble averaging the different terms in the equations are directly estimated, thereby allowing one to determine their relative importance. Measurements are made throughout the water column.

Two wave conditions are studied, one dominated by plunging type breakers and one dominated by spilling breakers. The different terms in the Reynold's averaged equation are studied both in the time domain and statistically over a five minute time series. All the calculated terms are important at least some of the time and cannot therefore be neglected, with the exception of the viscous stress term in the momentum equation which is a couple of orders of magnitude smaller than the remaining terms. Major differences between the spilling and plunging wave conditions are not evident. However, under plunging breakers, the turbulent diffusion is generally more important than the turbulent advection. For spilling waves, the magnitude of the horizontal advection and diffusion are on average in opposite directions. Additionally, the ratio of the time averaged Reynold's stress to the horizontal and vertical turbulent fluctuations is remarkably uniform for different locations in the surf zone. It is proposed that the surf zone can be understood as a type of unsteady shear layer.

Time averaged correlations between the horizontal velocity and the turbulent kinetic energy show differences between the spilling and plunging wave conditions which may help explain why spilling waves erode a beach and plunging waves result in accretion. Combined surf zone turbulence and sediment transport models must therefore calculate the temporal variation of the turbulence and its relation to the mean flow.

1. 1995 Fall Meeting

2. I will be applying for membership. My sponsor's AGU number is 04551935.

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4. O

5. (a) O05 Nearshore and Inner Shelf Processes

5. (b) 4546 Nearshore processes

4560 Surface waves and tides (1255)

4568 Turbulence, diffusion and mixing processes

6. oral presentation preferred

7. 50% in first author's dissertation.

8. \$50 check enclosed

9. C

ABSTRACT FORM FOR 1997 GSA ANNUAL MEETING

Complete all sections ① through ⑧ below.

① Type abstract completely within the large blue box below. Use 11 point type minimum.

No 14392

A SCIENCE TEACHING METHODS COURSE: USING A WETLANDS IMMERSION TO IMPLEMENT THE NATIONAL SCIENCE EDUCATION STANDARDS

KUBOTA, Carole A., Education Dept., Univ. of Washington, Bothell, Box 358500, 22011 26th Ave. SE, Bothell, WA 98021, kubota@u.washington.edu; and BOSS, Emmanuel, LADD, Carol, STRICKLAND, Richard, SULTAN, Nels, and MC MANUS, Dean A., School of Oceanography, Univ. of Washington, Box 357940, Seattle, WA 98195-7940.

The format of a new teacher certification course offered at the University of Washington, Bothell this year included a wetlands immersion experience with the assistance of four scientists (not wetland experts). The course implemented many of the National Standards to enhance these future educators' understanding of scientific inquiry. In the process, the scientists first witnessed teaching by the Standards.

Some examples of strategies by which Teaching Standards were implemented are: 1) students generated their own questions to answer by inquiry in the wetland, a "real phenomenon" that is familiar to them; 2) group collaboration developed a community of highly motivated science learners, 3) student learning of inquiry skills was assessed by e-mail with the scientists but needs improvement, and 4) the immersion format was chosen to allow time for extended study. Some of these strategies also implemented Professional Development Standards. Finally, one Assessment Standard is particularly relevant in that the students presented their results as posters for comment and feedback by students, instructor, and scientists.

The scientists were astounded by the motivation of the students, who were taking 16 quarter credits of course work and spending two days a week in their own elementary classrooms. Reflections written in the students' journals revealed that adherence to the Standards was the basis for the high motivation. Students, instructor, and scientists all benefited from the experience. One scientist has since received a teaching fellowship and another has changed the format of his course.

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- 5 engineering geology
- 6 environmental geology
- 7 geochemistry, aqueous/organic
- 8 geochemistry, other
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- 10 geophysics/tectonophysics
- 11 geoscience information
- 12 history of geology
- 13 hydrogeology
- 14 marine geology
- 15 micropaleontology
- 16 mineralogy/crystallography
- 17 paleoceanography/paleoclimatology
- 18 paleontology/paleobotany
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- 20 petrology, experimental
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- 22 petrology, metamorphic
- 23 planetary geology
- 24 Precambrian geology
- 25 public policy
- 26 Quaternary geology/geomorphology
- 27 remote sensing
- 28 sediments, carbonates
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National, science, education, standards, teaching

In box above, type the 5 most important key words in your abstract, separated by commas (hyphenated words okay).

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⑥ CHECK IF YOU ARE WILLING TO BE A SESSION CHAIR

⑦ SPEAKER'S IDENTITY AND MAILING ADDRESS—PLEASE TYPE!

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